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(54) ALUMINUM ALLOY MATERIAL EXCELLENT IN HIGH TEMPERATURE CREEP CHARACTERISTIC AND ITS PRODUCTION

(57)Abstract:

PROBLEM TO BE SOLVED: To improve the bending resistance of an alloy material in use under heating in the case of being applied to a heat roll of a copying machine or the like by composing it of an extruded material of an Al alloy contg. a specified amt. of Mn and controlling its electrical conductivity to the value equal to or below the specified one.

SOLUTION: This Al alloy material contains, by weight, 0.5 to l.5% Mn, and the balance Al with impurities. Then, its electrical conductivity is controlled to ≤37% IACS. The alloy material is produced by making a billet by an ordinary continuous casting system, thereafter, without executing homogenizing treatment, or executing rapid cooling after the homogenizing treatment, again heating it and executing hot extrusion working. In this way, the content of Mn solid solution in the matrix is controlled and the precipitation and dispersion of Al-Mn compds. are controlled to improve its creep characteristics at a high temp. For forming it into the stock for a heat roll, the material is subjected to port hole extrusion to form into the shape of a pipe, and, after that, for obtaining dimensional precision, preferably, cold drawing is executed.

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CLAIMS

[Claim(s)]
[Claim 1]An aluminum alloy material excellent in elevated-temperature creep property characterized by the following.
Mn: 0.5-1.5 % (it is below the same% of the weight).
It is the extrudate of an aluminum alloy which consists of remainder aluminum and an impurity, and conductivity is below 37%IACS.

[Claim 2]An aluminum alloy material excellent in elevated-temperature creep property characterized by the following.
Mn: 0.5-1.5 %.
It is the cold drawing material of an aluminum alloy which consists of remainder aluminum and an impurity, and conductivity is below 37%IACS.

[Claim 3]An aluminum alloy material excellent in the elevated-temperature creep property according to claim 1 or 2 containing less than Mg:2.0% (it is below the same excluding 0%) furthermore.
[Claim 4]An aluminum alloy material excellent in the elevated-temperature creep property according to claim 3 containing less than Cu:1.5% furthermore.
[Claim 5]An aluminum alloy material excellent in the elevated-temperature creep property according to claim 1 to 4 containing 1 of the sorts less than Si:0.5% and below Zn:0.5 %, and two sorts furthermore.
[Claim 6]An aluminum alloy material excellent in the elevated-temperature creep property according to claim 1 to 5 containing one sort in less than nickel:2.0% and less than Fe:1.0%, or two sorts furthermore.
[Claim 7]An aluminum alloy material excellent in the elevated-temperature creep property

according to claim 1 to 6 containing 1 of the sorts less than Ti:0.3% and below B:0.08 %, and two sorts or more furthermore less than Cr:0.3%, less than Zr:0.3%, and V:0.1% or less.

[Claim 8]A manufacturing method of an aluminum alloy material which was excellent in elevated-temperature creep property quenching after homogenization and performing hot extrusion processing without homogenizing an aluminum alloy ingot which has the presentation according to claim 1 to 7.

[Claim 9]A manufacturing method of an aluminum alloy material excellent in the elevated-temperature creep property according to claim 8 characterized by performing a cold drawing process further after hot extrusion processing.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention offers the outstanding elevated-temperature creep property, and relates to an aluminum alloy material excellent in elevated-temperature creep property suitable as an object for heat rolls used as an object for fixing of a toner, and a manufacturing method for the same in a copying machine etc. especially.
[0002]
[Description of the Prior Art]Since the heat roll used for a copying machine etc. is used in a 150-250 ** temperature requirement, as a raw material for heat rolls, By a light weight and nonmagnetic, while excelling in thermal conductivity, heat resistance characteristics are required and the aluminum alloy material of 5000 systems whose high temperature strength is comparatively high, or 6000 systems is used conventionally.
[0003]However, although these aluminum alloy materials are comparatively excellent in the static strength in an elevated temperature, Since the creep property in an elevated temperature is not enough, when it is used as a heat roll and load of the repeated stress by copy paper passage is carried out [be / it / under / heat roll use / setting], a bend occurs and there is a problem of being easy to become a cause of the fixing defect of a toner.
[0004]In order to solve the above-mentioned problem, these people offered the outstanding elevated-temperature creep property previously, and proposed the aluminum alloy raw material for heat rolls which has improved the bend-proof nature at the time of important heating use in a copying machine. (JP,9-170039,A)
[0005]
[Problem(s) to be Solved by the Invention]In order to obtain the aluminum alloy material which has improved elevated-temperature creep property further and was suitable also in the severe operating environment as a heat roll which can be equal to prolonged use, this invention, it is

made by using as a base the aluminum alloy proposed above as a result of having repeated an experiment and examination further especially about the relation between the alloy composition, and the description of a matrix and elevated-temperature creep property, and comes out. The purpose is in providing an aluminum alloy material whose bend-proof nature at the time of heating use improves, and a manufacturing method for the same, when it excels in creep property and applies to heat rolls, such as a copying machine.

[0006]
[Means for Solving the Problem]An aluminum alloy material excellent in elevated-temperature creep property by this invention for attaining the above-mentioned purpose, It is the extrudate of an aluminum alloy which contains Mn:0.5 - 1.5 % and consists of remainder aluminum and an impurity, It is the cold drawing material of an aluminum alloy which is characterized [1st] by conductivity being below 37%IACS, contains Mn:0.5 - 1.5 %, and consists of remainder aluminum and an impurity, and is characterized [2nd] by conductivity being below 37%IACS.
[0007]To containing less than Mg:2.0% further for the above-mentioned ingredient, and Mg, in addition, a thing for which less than Cu:1.5% is contained further, Si: Less than 0.5%, Zn : 1 of 0.5% or less of sorts and two sorts are contained, nickel: Less than 2.0%, Fe : 1 of 1.0% or less of sorts and two sorts are contained, And less than Cr:0.3%, less than Zr:0.3%, V:0.1% or less, Ti: It is characterized [constitutional / 3rd, 4th, 5th, 6th and 7th] by containing 1 of the sorts below B:0.08 %, and two sorts or more 0.3% or less.
[0008]A manufacturing method of an aluminum alloy material excellent in elevated-temperature creep property by this invention, Without homogenizing an aluminum alloy ingot of the above-mentioned presentation, it quenches after homogenization, is characterized [1st] by performing hot extrusion processing, and is characterized [2nd] by performing a cold drawing process further after extrusion.
[0009]If meaning and its reason for limitation of an alloy content in this invention are explained, by dissolving in a matrix or depositing an aluminum-Mn system compound minutely in a matrix, Mn will raise intensity of an alloy raw material and will raise elevated-temperature creep property. A desirable content range is 0.5 - 1.5 %, and by less than 0.5 %, the effect is small, and if contained exceeding 1.5 %, extrusion nature will fall. The still more desirable content range of Mn is 0.7 - 1.3 %.
[0010]Mg functions as dissolving in a matrix and raising intensity of an alloy. A desirable content range is below 2.0 %, and if 2.0 % is exceeded, extrusion nature will fall and it will become difficult [porthole extrusion] easily. Still more desirable content of Mg is a range below 0.9 %.
[0011]It is effective in Cu coexisting with Mg, depositing a compound of an aluminum-Cu-Mg system, and raising creep property in an elevated temperature especially. Desirable content is

below 1.5 %, more desirable content is the range of 0.1 - 1.5 %, and if contained exceeding 1.5 %, extrusion nature will fall. The still more desirable content range of Cu is 0.5 - 1.0 %.

[0012]By coexisting with Mg, Si deposits Mg_2Si and has a function which raises intensity of an alloy. A desirable content range is 0.5% or less, and if contained exceeding 0.5 %, big and rough Mg_2Si will deposit by elevated-temperature maintenance, and it will reduce intensity and elevated-temperature creep property.

[0013]By coexisting with Mg, Zn deposits a compound of $MgZn_2$ and others and raises intensity of an alloy raw material. Desirable content is a range below 0.5 %, and if 0.5 % is exceeded, intensity in an elevated temperature and creep property will fall.

[0014]nickel and Fe are elements contributed to improving strength of an alloy, and desirable content ranges are less than nickel:2.0% and less than Fe:1.0%. If contained exceeding a maximum, respectively, big and rough crystallized material and a sludge will generate with other coexistent elements, and the various characteristics of an alloy raw material will be degraded. Still more desirable content of nickel and Fe is the range of nickel:0.01 - 0.5 % and Fe:0.01 - 0.5 %.

[0015]In the crystalline structure which Cr, Zr, V, Ti, and B contribute to minuteness making of a recrystallization grain, and is formed by extrusion, (The crystal length of a direction vertical to the crystal length / direction of extrusion of the direction of extrusion) A ratio is made small, it is an element which raises elevated-temperature creep property, and an effect is acquired by making these one sort or two sorts or more contain. If each desirable content range is less than Cr:0.3%, less than Zr:0.3%, V:0.1% or less, less than Ti:0.3%, and below B:0.08 % and exceeds a maximum, respectively, big and rough crystallized material will be generated and intensity and creep property of an alloy will fall.

[0016]

[Embodiment of the Invention]After carrying out ingot making to a billet according to the usual continuous casting method, the aluminum alloy material of this invention is manufactured by performing hot extrusion processing, without giving homogenization, or is quenched after homogenization and manufactured by heating again and performing hot extrusion processing. In homogenizing, it is 550-660 ** in temperature preferably, and after performing heat-treatment of 1 hours or more preferably, it quenches by water cooling or other means, heats in temperature of 350-550 ** again preferably, and performs hot extrusion. In order to consider it as the raw material for heat rolls, after performing porthole extrusion and processing pipe shape, in order to acquire dimensional accuracy, a cold drawing process is performed.

[0017]By this invention's controlling the amount of Mn dissolution in a matrix, and controlling a deposit of an aluminum-Mn system compound and distribution, hot creep property is raised and these control is attained by adjusting the conductivity of material to below 37%IACS.

When conductivity exceeds IACS 37%, there are few amounts of dissolution of Mn in a matrix, and elevated-temperature creep property deteriorates.

[0018]

[Example]Billet (90 mm in diameter) of the aluminum alloy of the presentation shown in Table 1 by example 1 continuous casting After homogenizing on the conditions shown in Table 2, cast, use a porthole dice and at the temperature of 400 **. Hot extrusion processing by the extrusion rate applied in the usual extrusion molding was performed, the extruded pipe and round bar material of 20 mm in diameter and thickness 3mm cylindrical shape were manufactured, conductivity was measured, and extrusion nature was evaluated.

[0019]Load of the constant stress of 80MPa was carried out to the ram bar at the temperature of 200 **, the creep test held for 100 hours was done, and elevated-temperature creep property was investigated. The cold drawing process of the extrusion round bar material 20 mm in diameter was carried out to 16 mm in diameter (36% of workability), the same creep test was done, and creep property was evaluated. These results are shown in Table 2. In Table 2, evaluation of extrusion nature and the evaluation of creep property are as follows.

[0020]Extrusion nature: The propriety of porthole extrusion is investigated and that to which O and porthole extrusion were not made as for the thing in which porthole extrusion is possible is taken as x.

Creep property: That from which O and a fracture produced what a fracture did not produce in a creep test is taken as x.

[0021]Porthole extrusion is possible for each sample board according to this invention, and the outstanding elevated-temperature creep property is shown, without a fracture arising by the creep test of 100 hours at 200 ** so that it may see in Table 2.

[0022]

[Table 1]

試験材	組 成(wt %)							
	Mn	Mg	Cu	Si	Zn	Ni	Fe	Cr,Zr,V,Ti,B
1	1.4	--	—	--	--	--	--	
2	0.5	--	—	--	--	--	--	
3	0.9	1.9	—	--	--	--	--	
4	0.6	0.3	—	--	--	--	--	
5	0.8	0.8	0.2	--	--	--	--	
6	1.4	0.8	1.3	--	--	--	--	
7	0.5	--	—	0.3	--	--	--	
8	0.9	--	—	--	0.2	--	--	
9	0.9	1.9	—	--	--	1.0	--	
10	0.6	0.3	—	--	--	--	0.7	
11	0.8	0.8	0.2	--	--	--	--	Cr0.04
12	0.8	0.8	1.3	--	--	--	--	Zr0.1
13	0.9	--	—	--	--	--	--	V 0.06
14	0.9	0.6	—	--	--	--	--	Ti0.15,B0.05
15	0.9	0.5	0.8	--	--	--	0.5	
16	0.9	0.5	—	0.2	0.1	--	0.4	Cr0.1
17	0.9	1.0	—	0.3	--	--	0.3	Cr0.1,Zr0.2, Ti0.05
18	0.8	0.6	—	0.2	0.1	0.6	0.5	Cr0.1,Zr0.1, B0.07
19	0.8	0.7	0.7	0.2	0.3	0.5	0.3	V0.05,Ti0.06,B0.07
20	0.8	0.4	0.8	0.2	--	0.5	--	Cr0.1,V0.07,Ti0.05
21	0.8	0.6	0.7	0.3	0.1	0.3	--	Cr0.1,Zr0.1,Ti0.06

[0023]

[Table 2]

試験材	均質化処理条件	導電率%IACS	押出性	クリープ特性（押出材）	クリープ特性（引抜き材）
1	A	26.7	○	○	○
2	A	35.3	○	○	○
3	A	27.8	○	○	○
4	A	32.7	○	○	○
5	A	30.1	○	○	○
6	A	25.8	○	○	○
7	B	37.0	○	○	○
8	B	35.7	○	○	○
9	B	32.3	○	○	○
10	B	36.9	○	○	○
11	A	35.2	○	○	○
12	A	34.6	○	○	○
13	B	36.1	○	○	○
14	B	34.9	○	○	○
15	B	34.2	○	○	○
16	B	35.2	○	○	○
17	B	33.9	○	○	○
18	B	35.9	○	○	○
19	B	34.9	○	○	○
20	B	35.4	○	○	○
21	B	35.1	○	○	○

<<Table Note>> Homogenization A-:-homogenization-less B : 8h-> Water-cool at 630 **.[0024] By comparative example 1 continuous casting, after homogenizing on the conditions shown in Table 4, cast the billet (90 mm in diameter) of the aluminum alloy of the presentation shown in Table 3, use a porthole dice, and at the temperature of 400 **. Hot extrusion processing by the extrusion rate applied in the usual extrusion molding was performed, the extruded pipe and round bar material of 20 mm in diameter and thickness 3mm cylindrical shape were manufactured, conductivity was measured, and extrusion nature was evaluated.

[0025]Like Example 1, load of the constant stress of 80MPa was carried out to the ram bar at the temperature of 200 **, the creep test held for 100 hours was done, and elevated-temperature creep property was investigated. The cold drawing process of the extrusion round bar material 20 mm in diameter was carried out to 16 mm in diameter (36% of workability), the creep test with the same said of these was done, and creep property was evaluated. A result is shown in Table 4. In Tables 3-4, the underline was given to what separated from the conditions of this invention.

[0026]

[Table 3]

試験材	組 成(wt %)							
	Mn	Mg	Cu	Si	Zn	Ni	Fe	Cr,Zr,V,Ti,B
22	1.4	--	—	--	--	--	--	
23	0.5	--	—	--	--	--	--	
24	0.9	1.9	—	--	--	--	--	
25	0.9	0.3	—	--	--	--	--	
26	0.6	0.8	0.2	0.3	--	--	--	
27	0.8	0.8	1.3	--	0.1	--	--	
28	1.4	--	—	--	--	--	--	
29	0.5	--	—	--	--	--	0.3	
30	0.9	1.9	—	--	--	--	--	Cr0.1
31	0.9	0.3	—	--	--	--	--	
32	0.6	0.8	0.2	--	--	--	--	V 0.05
33	0.8	0.8	1.3	--	--	--	--	Ti0.1,B 0.05
34	1.8	--	—	0.2	--	--	--	Zr0.1
35	0.3	--	—	--	--	--	--	
36	0.9	2.5	—	--	--	0.1	--	Cr0.2
37	0.9	0.7	2.1	--	--	--	--	
38	1.8	--	—	--	--	--	--	
39	0.3	--	—	--	--	--	--	Cr0.1
40	0.9	2.5	—	--	--	--	--	Cr0.2
41	0.9	0.7	2.1	--	--	--	--	

[0027]

[Table 4]

試験材	均質化処理条件	導電率%IACS	押出性	クリープ特性（押出材）	クリープ特性（引抜き材）
22	C	39.9	○	×	×
23	C	40.1	○	×	×
24	C	37.1	○	×	×
25	C	40.8	○	×	×
26	C	37.9	○	×	×
27	C	37.5	○	×	×
28	D	43.0	○	×	×
29	D	42.7	○	×	×
30	D	39.2	○	×	×
31	D	42.1	○	×	×
32	D	39.9	○	×	×
33	D	39.6	○	×	×
34	A	27.0	×	○	○
35	A	37.1	○	×	×
36	A	30.4	×	○	○
37	A	31.7	×	○	○
38	B	33.4	×	○	○
39	B	38.4	○	×	×
40	B	33.4	×	○	○
41	B	34.5	×	○	○

<<Table Note>> Homogenization A:homogenization-less B: It is 8h-> water cooling at 630 **. It is C:600 ** and is 10h-> air cooling. It is D:500 ** and is 10h-> furnace cooling.[0028]As shown in Table 4, since sample board No. 22-33 have high conductivity and there are few amounts of Mn dissolution in a matrix, they are inferior in hot creep property. Since sample board No.34 and No.38 had much content of Mn, extrusion nature fell and they were not able to do porthole extrusion. Sample board No.36 and No.40 had many amounts of Mg, since sample board No.37 and No.41 had many amounts of Cu(s), extrusion nature fell and they were not able to do porthole extrusion.

[0029]Since sample board No.35 and No.39 have little content of Mn, a deposit of the aluminum-Mn system compound produced from dissolution of Mn and their distribution decrease, and the hot creep strength characteristic is inferior in them as a result.

[0030]

[Effect of the Invention]According to this invention, when it excels in elevated-temperature creep property and applies to a heat roll, the bend-proof nature at the time of heating use is improved, and extrusion nature is good, high-speed porthole extrusion is possible, and an aluminum alloy material suitable as a raw material for heat rolls and its manufacturing method

are provided especially.

[Translation done.]